Ballistic Research Laboratory Report No. 233

ESM/EWC/eme Aberdeen Proving Ground, Md April 2, 1942.

EXPERIMENTAL DATA FORMING THE BASIS FOR THE BOMBING TABLES BT-1100-A-3 FOR THE BOMB, DEMOLITION, 1100-LB., M33

Abstract

This report records the essential data on which the bombing tables, BT-1100-A-3, are based. A short description of the bomb is given as well as the mechanical constants of the bombs used. The methods used in range bombing and the methods of obtaining essential data are described. Also given are the methods used to determine the ballistic coefficients, as well as the methods used in constructing the bombing tables. Graphs showing the results of range bombing and graphs showing the fitted C: Y relations are included.

I. Purpose of Report

The purpose of this report is to record the essential details of the experimental work, the computing methods and the experimental data upon which the bombing tables, BT-1100-A-3, for the Bomb, Demolition, 1100-15., M33 are based.

II. <u>Description of Bombs</u>

PROPERTY OF U.S. ARMY STINFO BRANCH BRL, APG, MD. 21005

The Bombs, Demolition, 1100-15., M33 used in range bombing for the bombing tables, BT-1100-A-3, were made in accordance with Ordnance Department Drawing Number 82-0-15, dated September 27, 1934, and subsequent revisions, including that of May 14, 1940.

M30 series. The bomb body is made of steel and is 0.43 inch in thickness in the cylindrical part. The bombs dropped during 1938 and 1939 were assembled with Fuze, Bomb, Nose, M103 and Fuze, Bomb, Tail, M102. The M103 Fuze is an instantaneous-short delay nose fuze to be used with the M series demolition bombs. Both the M103 and the M102 Fuzes are vane type fuzes: All the bombs dropped in this range bombing program during 1938 and 1939 were equipped with aluminum box-type fins. The bombs dropped during 1940 were assembled with Fuze, Bomb, Nose, M103 and Fuze, Bomb, Tail, M106. The M106 Fuze is an inertia-plunger type fuze with a 45 second delay. All the bombs dropped during 1940 were

equipped with steel box-type fins. Although the drawings cited above specify that the bomb body is to be filled with TNT, correspondence 00 471.623/2791 dated April 14, 1938, specifies that it is to be loaded with 50/50 Amatol. The ratio of the weight of the 50/50 Amatol bursting charge to the total weight as dropped is 54 per cent.

III. Preparation of Bombs

The empty bomb bodies with their components were shipped to the Proving Ground where they were inert loaded and their components assembled. In order to obtain the highest uniformity of flight of which the bombs are capable, it is necessary that the variation in mechanical constants from bomb to bomb be kept as small as possible. In order to accomplish this, the bombs were loaded with a mixture of sand and soot in which the proportion of the two materials was adjusted to give the mixture a density equal to that of 50/50 Amatol, so that the specified weight of the completely loaded bomb was obtained when the cavity of the bomb was completely filled. Before being loaded into the bomb, the mixture was carefully blended in order to secure a uniform density.

That this method is adequate is indicated by the values of the mechanical constants given in the next paragraph.

IV. Mechanical Constants of Bombs

The mechanical constants of each bomb were determined before it was loaded into the airplane. The detailed results of these measurements are given in Appendix A. A summary of the results for the Bomb, Demolition, 1100-lb., M33 is given in the table below:

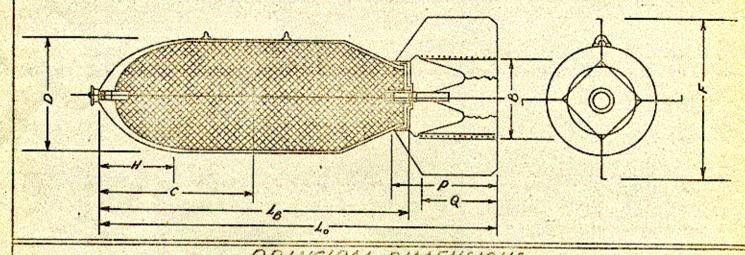
A more complete description of the method used in order to control the mechanical constants of the bombs used in the range bombing program is given in a memorandum prepared in the Ballistic Research Laboratory: "Procedure for Determination of the Mechanical Constants of Bombs".

PHYSICAL CHARACTERISTICS BOMB, DEMOLITION, 1100-LB., M33

DRG.NO.82-0-15

* (V)

REV.5-14-40



DIMENSION	INCHES	CALLOEDE	OF WARKS
UTINLASTON	MES	CALIBERS	REMARKS
	19.55	1.00	AS GIVEN ON DRAWING
В	13.25	.68	AS GIVEN ON DRAWING
F	27	1.38	AS GIVEN ON DRAWING
Lo	68.66	3.51	AS GIVEN ON ORAWING
L8	52.6	2.69	AS GIVEN ON DRAWING
Н	27.1	1.39	AS GIVEN ON DRAWING
P	17.9	.92	AS GIVEN ON DRAWING
Q	12.8		AS GIVEN ON DRAWING
С	26.84=0.237	1.37	MEAN FROM RANGE BOMBING STEEL FINS ALUMINUM FINS-26.56,0=0.20
C	26.0±25±.5	OF BOOY ASSEMBL	Y AS PRESCRIBED FOR PANGE BOMBING WITH TOLLHANCE

	COMPONENTS	WEIGHT (4)	REMARKS
X	BODY	493.	AS CIVEN ON DEADING INCLUDING SUSPENSION LUGS REAR CAP, FIN LOCK NUT, AND FUZE SEAT LINEAR
78,	ADAPTER-BOOSTER ,MIO2	1.37	AS GIVEN ON DRAWING
00	BURSTING CHARGE	618.	AS GIVEN ON DRAWING SO/SUAMATOL THELVO
55,	COMPLETE AS LOADED	1112.4	AS GIVEN ON DRAWING
7	" " "	1085 ± 15	PRESCRIBED FOR RANGE BOMBING
FIN	ASSEMBLY .	22.5	STEEL ALUMINUM-9.1 LB.
FUZ!	E, NOSE, M103	4.	AS GIVEN ON DRAWING
FUZ	E, TAIL, MI06	2.4	AS GIVEN ON DRAWING
COM	PLETE AS DROPPED	1141.3	AS GIVEN ON DRAWING
	" " STEEL FIMS	1115.4	ALUMINUM FINS-104.9 0 = 7.33

" " STEEL FINS 1115.4 #=6.15 ALUMINUM FINS-1104.9 #=7.33

EXPECTED MAXIMUM VARIATION IN WEIGHT AS LOADED = 1 19.52 LB.

RATIO, WEIGHT OF BURSTING CHARGE: WEIGHT AS DROPPED = 0.54

EXPERIMENTAL DESIGNATION:

STANDARDIZED BY: OCM

-	m	, ,	$\mathtt{I}_{\mathbf{L}}$	$\mathtt{I}_{\mathtt{T}}$
	Weight Complete as Dropped	Distance of Center of Gravity from Nose	Moment of Inertia about Longitudinal Axis	Moment of Inertia about Transverse Axis through Center of Gravity
	1b.	in.	lb.ft.2	lb.ft. ²
		Aluminu	ım Fins	
Mean Standard Deviation	1104.9	26.56	399.4	26 1844
Maximum Minimum	1114.9 1088.9	26.90 26.25	404.0 388.2	1846 1753
Number of Bombs	18	7	18	18
		Steel	Fins	
Mean Standard	1115.4	26.84	399.8	1901
Deviation Maximum Minimum	6.15 1126.9 1106.1	0.24 27.27 26.43	4.0 410.0 394.6	23 1936 1854
Number of Bombs	14	14	14	14

These statistics refer to all bombs for which a ballistic coefficient with respect to any element was obtained. The actual variations in weight of these bombs do not affect their flight characteristics sufficiently to cause a variation in ballistic coefficient large enough to be detected by the methods for estimating the ballistic coefficient which were used in the reduction of field data. The variation in center of gravity position and moments of inertia would, if sufficiently in excess of that for the present bombs, affect the yaw of the bombs and thereby the dispersion in the elements range, time of flight and trail. The small dispersion of the mechanical constants for these bombs indicates the efficacy of the method of loading described in this report. 1

A more complete description of the method followed in controlling the mechanical constants is given in Ballistic Research Laboratory Report No. 190: "The Computation of the Mechanical Constants of Bombs."

The center of gravity positions of the bombs summarized above were measured with fins and fuzes. However, the other eleven bombs with aluminum fins had their center of gravity positions measured without fins and fuzes. The following bombs had their center of gravity positions measured without fins and fuzes.

Program Group Serial Number	Date of Release Run Number	Distance of Center of Gravity from Nose in.
KS-1268	8/19/38-3	26.51
10	5	26.46
9	6	25.82
11	8/22/38-2	26.44
12	8/23/38-2	26.49
13	8/29/38-1	26.41
14	5/24/39-1	26.34
15	2	26.51
16	3	26.50
17	4	26.50
18	5	26.47

V. Description of the Range Bombing

The bombs in this range bombing program were dropped from the B-18, the B-18A, and the B-17B airplanes at a target anchored in Bush River in such a position that the release points were in the fields of view of the Vertical and Oblique Cameras Obscura. The direction of the approach to the release point on all runs was from southeast to northwest within 11°.

On all approaches on which bombs were dropped horizontal flight was maintained as nearly as possible. In all cases with the B-18A and the B-17B airplanes piloting was done by means of the automatic flight control equipment. In all cases with the B-18 airplane piloting was done by manual control.

In these airplanes the bomb racks are so arranged that the longitudinal axis of the bomb is nearly parallel to the thrust line of the airplane, Hence the initial yaw of the bomb in the vertical plane is nearly equal to the angle of attack of the airplane.

On all approaches with both the B-18 and the B-18A airplanes, the bombs were carried in the rear bank of the bomb racks. The center line of this rack is 12.8 feet to the rear of the point formed by the junction of the front edge of the wing with the fuse-

lage of the airplane, this junction being the point on the airplane plotted in the cameras obscura. The corresponding distance in the B-17B is 6.4 feet. 1

All bombs were dropped according to the current standard practice of the Air Corps, using the current standard bomb sight and a target in Bush River as an aiming point. The results of this range bombing are shown in Appendix B. For the purpose of this report, the displacement of the center of impact with respect to the target is of no special significance. The dispersion about the center of impact and other data summarized in Appendix B are, however, of considerable interest.

The bombs dropped were divided into groups and the endeavor was made to have the altitude and air speed within the group approximate as nearly as possible to certain specified values. These values were described as the standard altitude and the standard air speed.²

The number of bombs in each group and the standard altitude and standard air speed for each group are given in Appendix D. The reasons for the selection of these standard altitudes and air speeds are given in Sections VI and IX of this report.

The range bombing was conducted by the following:

Pilots:

Capt. D. W. Watkins, A.C. Capt. M. J. Lee, A.C. 1st Lt. L. H. Tull, A.C. 1st Lt. R. Billings, A.C. 1st Lt. G. Hatcher, A.C. 1st Lt. M. Cooper, A.C. 1st Lt. H. Estes, A.C. W.O., J. A. Lee, Sr. W.O., S. C. Smink

Bombardiers:

Capt. C. S. Thorpe, A.C. 1st Lt. M. F.Summerfelt, A.C. W.O., S. C. Smink

The effect of bomb bay release position on the estimated values of the ballistic coefficients is discussed in Ballistic Research Laboratory Report No. 136: "First Progress Report: On the Method of Reduction of Observations on the Elements of Bomb Trajectories."

² Compare the usage of these terms for statistical purposes in Sections VIII and IX of this report.

Proof Officers:

Lt. Col. K. F. Adamson, O.D. Capt. J. H. Weber, O.D. Capt. J. G. Shinkle, O.D. 1st Lt. J. A. Barclay, O.D. 1st Lt. J. D. Armitage, O.D.

VI. Ground Observations

The primary ground observational equipment employed was the Camera Obscura Installation. The position of the aircraft in space and its components of velocity were fundamental data obtained by reduction of observations made with this equipment.

The field data for determinations of times of flight were secured by the chronograph installation housed in the Vertical Camera Obscura. The instants of release and impact were recorded by this chronograph-hydrophone system which has been in use in the present form since 1937. In addition the field data for determination of the time of flight of 1 bomb were obtained by the Western Electric Camera Clock. The camera photographs the impact of the bomb on Bush River and the clock face within the camera at the same instant. The clock in the camera is started by the same radio release signal that is recorded by the chronograph-hydrophone system cited above. The rate of the camera at this time was approximately 150 frames per second.

The coordinates of the impacts referred to the camera coordinate system were obtained by the ground observers by means of azimuth instruments on three towers along the shore of Bush River and were furnished to the Bombing Unit of the

A basic description of the Camera Obscura Installation is given in the "First, Second and Third Progress Reports on Bomb Trajectory Study by the Camera Obscura Method" by Frank Short, F. V. Ludden and S. P. Willan. The equipment has been extensively modified and improved during 1938 and the current equipment and its accuracy are described in Ballistic Research Laboratory Report No. 144: "First Progress Report: On the Accuracy of the Camera Obscura Installation for Obtaining the Initial Data of Bomb Ballistics."

The calibration of this system and the measurement of the systematic errors to which it is subject were carried out in 1938 and are described in Ballistic Research Laboratory Report No. 130: "On the Measurement of the Time of Flight of Bombs." The absolute accuracy and internal precision of the method in actual practice has been determined recently and the results are given in Ballistic Research Laboratory Report No. 211: "Comparsion of Measures of the Time of Flight of Bombs by the Camera Obscura Chronograph and the Western Electric Clock."

Ballistic Research Laboratory. The ground observers also provided the dispersion data with reference to the target and the reduced meteorological data for securing corrections to the elements tabulated in the bombardier's approximate bombing tables. The latter results are graphically summarized in Appendix B, "Primary Results of Range Bombing."

The field data necessary for the reduction of the effects of non-standard meteorological conditions were obtained from two sources. The data secured by the camera observers were the coordinates on the camera plotting boards of smoke puffs at regular; time intervals for a series of altitudes, to be used in obtaining ballistic winds; the velocity and the direction of the wind at the earth's surface; and the temperature, the relative humidity and the barometric pressure of the air at the earth's surface. The data secured by the Range Observation Section observers were the spatial positions of a balloon at regular time intervals, and the velocity and direction of the wind at the earth's surface. The temperature and barometric pressure at a series of altitudes were obtained from the bombing flight records of the bombardier. These data were partially reduced by the Range Observation Section and were furnished to the Bombing Unit in the form of tables of:

- (1) The actual wind components at a series of altitudes, and
- (2) The density of the air at a series of altitudes relative to standard ordnance air density structure.

The actual wind components were taken along a fixed line of known azimuth in the bombing lane, with the sign positive when taken along the direction of flight and positive when taken to the right. The actual wind components and the densities were obtained as near to the time the bombs were dropped as was practicable.

Field data on range bombing with the Bomb, Demolition, 1100-1b., M33 for the bombing tables, BT-1100-A-2, were obtained from the program carried out between June 6, 1938 and May 24, 1939. This included range bombing at 2,000, 5,000, 10,000 and 15,000 foot altitudes. The advance of ballistic theory and increased accuracy of measurement during 1938 and 1939 showed that better results can be obtained from groupings at the maximum obtainable altitude of release, a central altitude and a low altitude. Therefore, between July 6, 1940 and November 20, 1940, range bombing was carried out at 10,000 and 25,000 foot altitudes in accordance with the program outlined in the 2nd Ind. to file 00 471.3/1764. These two altitude groups with the four altitude groups used as the basis for the bombing tables, BT-1100-A-2, comprised the range bombing data for the bombing tables, BT-1100-A-3. However the 15,000 foot altitude group

was given a weight of zero. This was done because the bombs in this group were equipped with aluminum fins and it was found, as the result of stability tests at the Proving Ground, that the M33 bombs so equipped were unstable in flight when dropped from this altitude. Field data for both range and time of flight were obtained and trail determinations were made wherever possible. A total of 32 ranges, 28 times of flight and 27 trails was obtained.

VII. Reduction of Field Data

The data secured by the ground observers at the cameras were utilized to obtain the position and velocity of the airplane at the instant of release. The data secured by the ground observers at the azimuth instruments were utilized to obtain the positions of impact of the bombs. The time intervals obtained from the chronograph strip were employed to determine the uncorrected interval between release and impact. The time intervals from the Western Electric Camera film were likewise utilized. These data were then corrected for instrumental errors.

VIII. Determination of Ballistic Coefficient

The reduction of field data furnished values of range and time of flight corresponding to a certain set of known values of altitude and air speed, but containing the effects of departures from standard ballistic table conditions. The method of reduction of field data in order to obtain ballistic coefficients with respect to range, time of flight and trail is discussed very briefly in Ballistic Research Laboratory Report No. 191. The

- As a result of these stability tests steel fins were classified as standard components for all demolition bombs.
- ² On October 22, 1940, Run No. 3, KS-126-6, the measured range was greater than the range in vacuo which indicated a probable lag in bomb rack operation. It was therefore not included in the mean.
- The character of these instrumental errors is discussed in Ballistic Research Laboratory Reports No. 144, 130 and 211, previously cited.
- Standard ballistic table conditions and standard bombing table conditions are discussed and compared in Ballistic Research Laboratory Report No. 145: "On the Theory of Motion of the Bomb."
- The method of reduction of field data in order to obtain ballistic coefficients with respect to range, time of flight and trail has undergone considerable evolution. The reports from which the present methods were developed include: Ballistic Research Laboratory File E-IV-3, "Explanations and Comparisons of the Camera Obscura Methods of Computation"; "Computation of Firing Tables for the U.S. Army"; and Ballistic Research Laboratory Report No. 136, previously cited.

computation of the ballistic coefficients is carried out by means of a Bomb Ballistic Reduction Table which was prepared in the Ballistic Research Laboratory.

In accordance with the principles remarked above the ballistic coefficients corresponding to the ranges, times of flight and trails were then deduced for each individual bomb. From these coefficients the ranges, times of flight and trails were then computed for the standard altitude and standard air speed of the group to which the bomb belonged. These are called the "standard ranges", the "standard times of flight" and the "standard trails", or in general, the "standard elements" and are given in Appendix C together with the corresponding ballistic coefficients. This appendix also lists the program, the group, the serial number stamped on the bomb, the date of release and the run number, the last two providing for comparison with Appendices A and B.

The standard elements and the ballistic coefficients corresponding thereto contain the effects of certain unknown instrumental inaccuracies and of certain departures from standard bombing table conditions which it was not feasible to remove in advance. However, the effects of these sources of dispersion were partially removed by the process used for construction of the bombing tables.

IX. Construction of Tables

The experimental data from which the ballistic coefficients with respect to range, time of flight and trail were determined fell into 5 altitude groups. The groups were for standard altitudes of 2,000, 5,000, 10,000, 15,000 and 25,000 feet. The dependence of the ballistic coefficients upon altitude of release was determined from these 5 groups.

The mean standard elements for a standard true air speed and altitude were determined for each altitude group. The mean standard element is the arithmetic mean of the individual standard elements. The individual standard elements used in computing the mean standard elements had been reduced to the group standard altitude and true air speed. The use of the mean standard elements reduces the influence of the accidental errors in the individual standard elements upon the elements tabulated in the bombing table. The ballistic coefficients corresponding to these mean standard elements were then deduced. The forms of the functional dependence upon altitude of the three ballistic coefficients have been derived theoretically and verified empirically. The lift is the cause mainly responsible for the character of the variation of the ballistic coefficients with

A discussion of the ballistic coefficients corresponding to range, time of flight and trail is given in Bellistic Research Laboratory Report No. 143: "Errors in Trail Resulting from Ignoring Either the Measured Range or the Measured Time of Flight."

The derivation of the form of these relations between the ballistic coefficients and the altitudes of release is discussed in Ballistic Research Laboratory Report No. 145, previously sited.

altitude. The lift is due to the yaw arising from the initial angular velocity of the tangent to the trajectory. The effects of lift are allowed to remain in the ballistic coefficients corresponding to the mean standard elements. The functional relations referred to are:

These curves each contain two empirical quantities k and C_∞ . The subscript $^\infty$ refers to the mean effective ballistic coefficient for infinite altitude, and k is a parameter determining the shape of the curve.

A new procedure for estimating the values of $C_{\chi_{\infty}}$, $C_{T_{\infty}}$, $C_{\chi_{\infty}}$ k_{χ} , k_{T} , and k_{λ} was in use when these bombing tables were computed. The first modification consisted in changing the method of weighting the points. The earlier procedure assigned weights proportional to the product of the number of bombs in the group and a factor dependent upon a priori considerations of the probable accuracy of the determination. No account was taken of the fact that the probable error of bombing is an increasing function of the altitude of release. In consequence, unduly great weight was attached to the groups of bombs at the high altitude. The new procedure for range and trail used weights proportional to the product of the number of bombs in the group, a factor dependent upon a priori considerations of the probable accuracy of the determination and the reciprocal of altitude of release. The new procedure for the time of flight used weights proportional to the product of the number of bombs in the group, a factor dependent upon a priori considerations of the probable accuracy of the determination, the reciprocal of the altitude and the standard true air speed. The second modification consisted

in a change of the functions to be minimized. The function

PROPERTY OF THE SERVE STINFO BLOTCH BELL, ATG. 100. 21000 minimized in the earlier procedure was the sum of the weighted squares of the residuals of the reciprocal ballistic coefficients. The function minimized in the new procedure was the sum of the weighted squares of the residual differences between the mean standard elements and those elements which would result from the use of the bombing tables.! This modification has resulted in much smaller probable ballistic errors for bombing tables.? A considerable improvement in the accuracy of the bombing tables, has resulted therefrom. The improvement is shown by the magnitude, as compared with earlier bombing tables, of the differences between the observed mean standard ranges, times of flight and trails, and those elements which would result from employment of these tables.

The values c_{X_∞} , c_{T_∞} , c_{λ,k_X} , k_T and k_λ were deduced by the new procedure described above. The values were:

$${}^{C}X_{\infty} = 2.527$$
; ${}^{C}T_{\infty} = 5.145$; ${}^{C}\lambda_{\infty} = 3.405$
 ${}^{k}X = -16.148$; ${}^{k}T = 2.321$; ${}^{k}\lambda = -6.963$

The observed and fitted ballistic coefficients are compared in Tables 1, 2 and 3 of Appendix D. The relations between the fitted ballistic coefficients and the altitudes of release are shown in Plots I, II and III of Appendix D. The fitting provides for obtaining the ballistic coefficient for any altitude of release. The actual points on the plots in Appendix D are shown by dots and their probable errors by horizontal strokes placed on the sides of the dots. The computed C: Y relations are shown by heavy lines. The dotted lines furnish the probable error of forecast bands. The band is determined by addition and substraction of the probable error of the computed C: Y relation from the curve.

The construction of the Table of DS followed general instructions given in file 00 063.2/4524(Confidential). The trail angles, times of flight and dropping angles were obtained by interpolation with the fitted C: Y relations in the Bomb Ballistic Auxiliary Tables, computed in the Ballistic Research

¹ The new procedure is described more completely in Ballistic Research Laboratory Report No. 136, previously cited.

The ballistic error is a term originally used by British ballisticians to denote the difference between the bombing table range and the mean standard range for the same conditions. The ballistic error is denoted by $X-X_{\mathbf{r}}$ in this report.

Laboratory. These tables give trail angles, times of flight and dropping angles as functions of the altitude of release, Y; the calibrated indicated air speed, V, or true ground speed, V_g ; and the reciprocal ballistic coefficient, $\frac{1}{C}$. The intervals

of the arguments used in the Bomb Ballistic Auxiliary Tables are the same as those used in the present series of abridged bombing tables. The small differences between the observed mean standard ranges, times of flight and trails, and those elements which would result from employment of these tables are shown in the columns $X-X_f$, $T-T_f$ and $\lambda-\lambda_f$ given in Tables 1, 2 and 3 of

Appendix D. These differences are compared with the probable errors of the observed mean standard elements in plots IV, V and VI of Appendix D. The importance of employment of the fitted ${}^{\rm C}_{\rm X}$: Y, ${}^{\rm C}_{\rm T}$: Y and ${}^{\rm C}_{\rm A}$: Y curves is shown by the small y magnitude of these differences.

The range of arguments included in these bombing tables, BT-1100-A-3, is indicated in the table below:

	mi.,	eed /hr.	Altit	
Element	Mini- mum	Maxi- mum	Mini- mum	Maxi- mum
Trail Angle (Calibrated Indicated Air Speed)	100	250	1800	35000
DS (Calibrated Indicated Air Speed)	10	 60	1200	36000
Time of Flight (Calibrated Indicated Air Speed)	10	60	1000	36000
Dropping Angle (Ground Speed)	100	250	100	10000
Provisi	onal			
Trail Angle (Calibrated Indicated Air Speed)	200	400	1800	35000
Time of Flight (Calibrated Indicated Air Speed)	160	320	1000	35000

E. S. Martin

E. S. Martin

E. W. Crump

Appendix A

Mechanical Constants of Bombs

Appendix A

Mechanical Constants of Bombs 1

		m	=	I _L	$\mathtt{I}_{\mathtt{T}}$
Program Group Serial Number	Date of Release Run Number	Weight Complete as Dropped	x Distance of Center of Gravity from Nose	Moment of Inertia about Longi-tudinal	Moment of Inertia about Transverse Axis through Center of
		lb.	in.	Axis lb.ft. ²	Gravity lb.ft. ²
KS-1262 3 1 4 5 6 8 7 10 9 11 12 13 14 15 16 17 18 1 2 4 3 8 7 6 5 11 12 9 10 11 12 13 14 15 16 17 18 19 19 10 10 10 10 10 10 10 10 10 10 10 10 10	6/6/382 6/14/38-1 6/30/38-1 2 8/19/38-3 4 5 6 8/22/38-2 8/23/38-2 8/29/38-1 5/24/39-1 2 3 4 5 7/6/401 2 7/10/40-1 2 10/22/40-1 2 3 4 11/4/40-1 2 3 4 11/20/40-1	1092.0 1105.0 1110.5 1098.0 1105.0 1100.9 1094.0 1100.9 1109.9 1106.9 1106.9 1107.9 1106.9 1114.0 1107.9 1113.0 1126.9 1111.9 1113.0 1126.9 1117.8 1119.3 1110.6 1113.7 1106.1 1113.7 1106.1	26.55 26.90 26.40 26.76 26.55 26.48 26.25 26.25 26.70 27.17 27.17 27.27 26.56 26.56 27.03 26.43 26.43 26.69 26.69 26.69 26.72	401.0 403.9 403.9 403.6 403.6 403.6 4002.2 403.6 4	1771 1813 1834 1801 1812 1821 1762 1765 1813 1817 1846 1775 1798 1779 1822 1790 1812 1916 1877 1923 1374 1909 1920 1907 1936 1878 1878 1878 1878 1878 1878 1903 1920 1882 1912

¹ Bombs dropped previous to 1940 had aluminum fins; bombs dropped after 1939 had steel fins.

Appendix B

Primary Results of Range Bombing

	The second second	-			ND D.		T .	1,450		AIR:	بمنتث	4		SKY
	ARGET	ROM T	IONS F	-	- GLIDE		GR'NO.		R SPEE		TUDE		TIME	2000
Stone	CTION	DEFILE	VGE	RAI	GRND.	2000	SPEED GR'ND	UE		CAL	GR'NO.		0F	BOMB
0.000	LEFT	RIGHT	SHORT	OVER	088.		CBS.	GRND.	AIR OBS.	.IND	OBS	美国国际公司	REL	NO.
	FT	FT	FT.	FT	FTANN	FT/MIN	M/HR	M/HR		M/HR	FT	FT		(4) (2) (4) (4)
					April 1	A 4								7
	192	7 19.		228	+1-2.8		123.7	156.1	157.0	134	Annual Street, Square,	10490	the second second second	2
	117			123	-39.3		119.5	156.5	158.2	135	10461	10465	3:11	3
														14
		1.7										erec.	715	5 6
		919				ليتيا	<u> </u>	ارتديا	64.4		110710	A1 DA	EDENT	
	155	37 × 31 €		176		OF THE	THE PERSON NAMED IN COLUMN 2 IS NOT THE OWNER, OF THE OWNER, OWNE			WIND		AL BAI	NGE:-	DA
	8	2.5		5	-	DEVIATI			-1.3	ROSS:			NGE C	NA.
1		USED	TIONS	CORREC	2000	STREET, STREET, ST.		12:53	ive's "	DAME -	4	- of +e		4
	EFI.:	E p	RANG	. IN	MILS	17.0		17.0 36.9	M/HR)	Y: (ELOCIT E. VELI	FACE, V	SUR	
	.2 LT.		-1.3	in .	VYIA	38.1		32.		OCITY.	JVEL	LISTIC		WIND
i		4-1				77.6°		277.	TO)	WITH (AZIN			
			-0.6	II.Y	DENS	972		0.979		EACEN	C (SUR	SURFE		DENSI
	.2 LT.	· (-1.9	AL.	101	988		0.99	10		G (A86)			
	111	13437	. 1111			77	77.1882	1	145. I	i i		147.4		
1				7-1							<u>n</u>	2 1		
1										444	1	13-1	-12	
-					12 6						10	1/2	130	
1				11111			2				1	S/ 18		
-											信	5/		
1							C.			1		10		
1		- :					- + 0			/	1/4			1991
-						-4:4					- X			
1		(*' <u> </u> }-,				3					/			
-	<u> </u>						30 -	rist.	22 6 3		1 3			
-	FE			140						FLIGHT	DIRECTION	4		
-		-17			1 15 1	- F	7.7				ASSESSMENT OF THE PARTY OF	17	415	
-	7		711		70							14.5		
-	DISPERSION IN	-1.4	ET	TAR	4	-4-4	orbit.			i = 1		147		
-	, M		AND RESERVE							-1-1	3	ECENE	-+	+++
	Sign	7 1					CHO	Vici - L	20	ACTO F	AL INL	EGEND	OUR NEWSON	144
-					是有4	(EU)	ONKEG			ACTS (T				
I	1		1 E-1			20	1.4.7.		IMPAU	1 I	ML CEN	AUIO	/4	1.74
					s	NOITIONS	RIC CO	OSPHE	OR ATM	IONS FO	ORREGI	OTE: C	N	
1	2,,123								95	N. C = 3. N	ASED O	+B	-1:1	
ı		and the second second	TOTAL PLANSAGE TOTAL PROPERTY.	ATTENDED AND A STATE OF		and the state of the last	1951/07(943HB)	ACCOUNT OF THE PARTY OF	4977 61 72 44	CHARLES THE RESERVE	O'CLAST TO STATE OF	And the last of the last	THE RESERVE OF THE PARTY OF THE	CARLES OF SHIPE

JUNE 14, 1938 HOO LB. DEMOLITION BOMB M33 AIRPLANE BIB PILOT LT. L. H. TULL BOMBARDIER: SGT. S. C. SMINK AIR: TRAIL AND D.S. BASED ON C = 3.54 ALTITUDE. GRND. CLIMB-GLIDE DEVIATIONS FROM TARGET AIR SPEED TIME SPEED AIR BOMB AIR 4 GRIND CAL. TRUE GR'ND. RANGE DEFLECTION OF-GR'ND. AIR GRND 088 085. INO NO. OBS. OBS OVER SHORT RIGHT LEFT REL. M/HR M/HR M/HR FT/MIN FT/MIN FT. FT. FT 10:22 10250 10206 133 155.3 155.8 140.7 +25.8 27 51 10:58 10390 103381 134 156.8 158.2 142.2 69 105 3 4 6 DIFFERENTIAL BALLISTIC WIND M/HR. CENTER OF IMPACT 48 27 RANGE: -1.2 CROSS: -2.7 MEAN DEVIATION 21 TIME 11:18 9:23 CORRECTIONS USED SURFACE, VELOCITY (M/HR) 8.0 5.0 MILS IN RANGE DEFL 20.7 20.0 BALLISTIC (VELOCITY ... 17.8 16.7 WIND -0.30.4 LT. 37.9° 36.0° DENSITY AT SURFACE +0.1 0.999 0.990 DENSITY REALLISTIC (SURFACE) 1.005 1.000 TOTAL -0.2(BALLISTIC (AR OBS.) 0.994 0.997 0.4 LT. 1100 WIND AT ALT BALLISTIC WIND C.I. Z TARGET RECTION 100 ACTUAL IMPACTS (TRAIL ANGLE CORRECTED) ACTUAL CENTER OF IMPACT

100.

LT.

DEFLECTION IN FEET

RT.

100

JUNE 30, 1938 AIRPLANE

Control of the Control		ALTI	TUDE !	Al	R SPEE	D -	GR'NO.	CLIMB.	GLIDE	DEVIAT	IONS F	ROM	TARGET
BOMB	TIME	AIR	GRIND	CAL:	TR	UE ·	SPEED	AIR	GR'ND.	RAN	IGE .	DEFL	ECTION
NO.	1000	085	OBS:	. IND.	AIR OBS	GRIND.	GR'ND. OBS.	CBS	OBS.	OVER	SHORT	RIGHT	LEFT
	REL.	FT.	FT	M/HR		M/HR	M/HR	FT/MIN	FT/MIN.	FT	FT.	→ FT.	FT.
1.	10:32	10380	10363	134	156.9	158.6	152.0		-0.7		9	126	1.0
2	10:41	10410	10412	133	155.7	153.0	147.5	- 3	+0.7	o otes	12		51.
3 . 4				أعجبت	1	-					0:4		
5			15	77.77						100			
6								•		****		7	1
	ERENT	IAL BA	LLISTI	C WINE	M/HF	. GE	NTER	OF IMP	ACT		Ťi.	38	1777
The second second second	NGE: -	THE RESERVE THE PERSON NAMED IN COLUMN	THE RESERVE OF THE PARTY OF	CROSS:	CALLS OF MANAGEMENT AND ADDRESS.		MEAN				2		89
				IINE .		9:09)	1:23	de la	CORRE	CTIONS	USED	
			VELOGI	Y (M/HR1	7.		3.0	MILS	IN	RANG	E	DEFL.
CHIW	THE RESERVE	STATE OF STREET	DE, VEL	OCITY	•	10. 8.	0	8.8 7.8	W	4 4 4 4 4	-0.4	100	0.4 RT.
44.7		LISTIC	AZII	MUTH (TO)	311.	5° 2	88.8°	ļ		,		
DENS		T SURF	AGE IC (SUR	EACE)		0,99		0.985	DEN		0	-+-	<u> Tidi</u>
JEMA			IC LAIR		12.3	0.98		.986	ro	TAL	-0.4		0.4 RT.
1						it il.			90,000	11	2.7	1.1.	
			9										
		18	S					200					
		12	12						21 27	in his		TAKE	1.4
	1. / 211.	ALTITUDE	1.181					of the					111
		12	The state of the state of										17.1
11:44				1	CE WIT	10							1:
- Hi			3/	SURF						1			+-1-
	TV 1068		1		121 271	1						- , . ts	FEET
4.1			1					1916	TAR	GET			Z Z
			DIRECTION OF FLIGHT				11/25	2		C.I		3113	
		4	FLIGHT		1.17					0			DISPERSION
		-1 -1 -1	PIE P										i ä
							1	12/5/1		7-2-18			DISE
						21	14			474 74			14. 1.
7.													1000
	777	LEGENE	UALL IM	PACTO	TDAIL	ANGLE	CORRE	CTED		7 27		4 8	1 3 3 3
			UAL CE		OF IMPA		COUKE		estes.	g 7 3			17.3
District State of	10.0425.01.55.0375	200	10000					25741.64		14.00	Land Com	Marie Land	ALC: LEL
	100			1000			10 70 4			2000年			
	i ka					15 27	7.1	341					

AUG. 19, 1938

1100 LB. DEMOLITION BOMB M33

71	TIME		TUDE.	AIR.	RISPE	۵	and the second second	CLING OR	- and the second	CEVIAI		ROM	TARGET
BOME	OF	AIR .	GR'ND.	CAL.	A CONTRACTOR OF THE PARTY OF TH	UE :	GRIND	G INF	100	RAN	GE .	DEFL	ECTION
NO.		083.	OBS.	INO	AIR, OBS	GR'ND OBS.	088.	OBS.	RANGE	OVER	SHORT	RIGHT	LEFT
	REL.	FT.	FT.	M/HP			AUGUST OF THE STREET	E VANN	Ft	FT	fr.	FT.	FT
10.				4.7		7	N-7 (- 1-)	1 10 1		7,100 172	P.		1,
2			95 (1965)						1.7		11.		100
3	1:50	15870	15791	123	157.8	146.0	135.8	-198.3	5919	48		96	11.00
4.	1:55	15880	15836	123	157.9	146.9	136.5	-194.9	6104	176	1.0		45
5			17 8			14 10 12		10/18/19					* 0 *
6	<u> </u>	ــــــــــــــــــــــــــــــــــــــ		w								j.	
	5		13808	. ,,,,,,,,,		ÇE	NTER	OF IMP	CT	110	7 X 7 X =	26	
· / / / /			-			Particular (part	the plant	DEVIAT	ioń .	6	2	() ()	71-
<u></u>			-	TIME I	See See	12:3		2:43		CORRE	CTIONS	NaED	
WIN			TITUDE			11.0		10.0 3 12.7	MILS	(IN or	RANG	E .	DEFL
			RENTIAL			11.2 -1.7		12.6	, wi	NO .	— o.з		0.3 RT.
	400	BAL.	LISTIC	- Jordo	53	+1.7	NEW YORK THE	-1.9 0.966	DEN	SITY	- o.s		
DENSI	TY, 30	ALLIST)	IC (SÚR IC (ÀIR			0.96 0.99 0.96	4 (0.966	> 10	TAL	· 1.8		0.3 RT.
					1 3	/							
		E TANK	195		(3)	Milde.		Kallin.		4			THE P
		7 S N. 7		77/	5/					8			101-5
		100		4 8	2/2/		i phre	F. T.,	3.3	3540			
	71.7 T.		F415	0/0/	1 7.7	WEG	Tubber	i i i i i	H.H.		C.I.	9.71	: "TE
100		7.10		OMIN TO							69	F. F.	
			2 4 62	1/				1-1-	Netzei	i i i i i i			
		114.1		/									3 1 1
			/										
		1511	1 z	_ P.		4122	200	28 1	En	IAH	GET		Z
		4	DIRECTION	FLIGHT	13.2		li iii						DISPERSION
4		0/	EC	NAME AND ADDRESS OF THE PARTY.			7.4 -7	1.47		C12 18			E. E.
			l ta	8					(4.7)		437.5	1	S
	4/	(; in:			1.11	erilib.	11 11	Mala to		139 157	Maria da la companya		
101	# / S			1 1 2 2 2 4 1			<u> </u>			-71		+	1 11.
-, L in	2/			14/	11:4.	4	1. 123		14	1.4		A., L.	1.5
1,1		LEGEN	}	131 4						1000			
		@ ACT	UAL IM	PACTS	TRAIL	ANGLE	CORRE	CTED)					1-4
	A 186 Y 186 Y	100	LONG BURNERS	CHARLES OF STREET	he 40.00	A245 A589		1	100 100 100	DANS	41.7	THE PARTY	
1.		ACI	UAL CE	NIER	OF TIME	101	10.2 4.5	1.00	Kt Tolle	2.7. T.	Elizabeth.	100	

SKY	VE -	11. 11. 1	特化的	AIR"			** T	RAIL "A	NO D.S	BASE	D ON	G = 4.0	04	
	*****	ALTI	TUDE	(A	R SPE	0		CLIMB	Sec.	CEVÍAT	TONS F	ROM 1	TARGET	
BOMB	TIME	AIR	GRIND	CAL.	TR	UE.	SPEEC	GLIDE	HOR.	RAN	(GE	DEFL	ECTION	
NO.	OF	085.	CBS.	JND.	AIR	GR'NO	GR'ND OBS.	GR'ND.	RANGE	OVER	SHORT	RIGHT	LEFT	
à	REL	FT	F 7.	M/HR	M/AR	MYHR	M/HR	FT/MIN.	FT	FT.	FT	FT.	FT.	
1:	F				777			1 33		1. 11				
2			8 J. C. L.			, · .	1. 7. 7	13.5	- J.			1200		
3			X 3X	**	1.13			1			2.		1000	
5	4100	JEOOF	15000	107	150.0								1	
6 '	the later is the same of the later is the la	Afternoon come of passions	15928 15816	COMPANY OF THE PARKET	Contract the second second	the other transmit for the con-	The second second	-206.2 -196.6	All the second s	135		12 15		
1		Licose	,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	L	101.0	THE RESERVED	The second second	OF IMP		182		14		
, T								DEVIAT			7	-	2	
				TIME		2:43		OL CAMA			CTIONS			
Suksy		SURFAC			100 m	10.0								K.
WW	0	AT ALT	DTUDE .	64-J		12.7			MICS	111	RANG	Ε, -1	DEFL	
VELO		DIFFER		(RAN	3E	12.6			7 WII	401 - E	– 0.2	. c	0.3 RT.	
State.	A CONTRACT OF THE PARTY OF THE		CHARLES AND AND AND ADDRESS.	RANG GROS	SS /	+1.9			DEN	SITY	- 0.9			10.15
DENSIT		FESURE MULISTI	ACE 144 C (SUR	FACEY		0.96		4 40 1		<u> </u>				
			IS TAIR			0.96			TO	TAC.	1.1		0.3 RT.	
			71.70				100							300
					3			10 m						300
4.4.4				77/5				a the						
13.7			100064	AAA	7.		31.5				5			
				14 A				1.7						
113 11											C.I.			200
[4]						77			1571 CS					
100	70 10 10		1	1,100				15, 157		33 343	6		. 40	
[][]		X [7]	do!	1	4			1.0				J. J. J.	i la	
1119			SURFACE WIN	Ę i	0,4								DISPERSION IN FEET	100
			<i>¥</i> /€	FLIGHT									- E	
\vdash \vdash \vdash \vdash			DIRECTION	u. u.									Sio	+
177.3		ii ir	3	0	K-14			1.121		TAR	GET:		F. S.	
	1		1		18.0]		ls is	.0
12-1	. Pality											1 2	15 to 10 to	
	7	LEGEND	1.5										1	7
1-4-1				NTER			CORR	ECTED)						
		- AUI	OML OF	TT CA	OF INITA									100
			./					1 - 4 -		2.2.12			11.05	
100	5231		April Con					10710	DEF	LECTIO	IN FE	ET	1 100	45

AUG. 22, 1938

1100 LB. DEMOLITION BOMB M33

AIRPLANE B 18

100

RT.

		ALTI	TUCE"	200	R SPE		AND ADDRESS OF THE SECOND				DEVIAT	IONS F	FOM	TA	RGET	
омв	TIME	AIR.	GR'ND	CAL.	TR	UE,	SPEE	10	OR .	HOR	PAN	GE :	DEF	LE	OTION	1
NO.	OF:	085	ces	IND.		GR'ND.	GRN	D g	a'NO	RANGE	OYER	SHORT	RIG	47	LEFT	
100	REL	FT	FT	M/HR	M/HR		M/HI	JF)	ZMIN.	FT.	FT	FI	F		FT.	1
i.		7 - Y	7				1,2				77	10.75		51		
2.	10:35	5350	5358	128	139.3	140.9	129.0	0 -	25.9	3484	165	7. Sept	4	5	3,73	
3	2.45			100	(1 a)			4	4.4			<u> </u>	1	\dashv		4
. 4 . 5				4			11.7						-	-+		+
6.		· • • • • • • • • • • • • • • • • • • •		1	-				<u> </u>	27,77			175			1
17.	75.5		-	1307		CE	NYER	OF	IMP.	ACT	93.			13		1
14	77						MEA	v Di	EVIAT	ION.				6		
5117				TIME		9:5		10:		-	CORRE	CTIONS				7
	(SURFAC	Œ.	1.35		8.0		7.			IN.	RANG		-	EFL)	1
WIT	VD :		TIT UDE.			12.5		13.	9							4
	th.	DIFFER	RENTIAL			-0.6		-1.	2	4	9D - 11	- 0.		0.	4 RT.	
e i i uc	A Visit of the latest three	THE RESERVE OF THE PARTY OF THE	LISTIC	lcro	55	+3.1		+2.		DEN	SITY	- 0.6	6	-		
DENS	The second secon	T SURF	IC (SUR	FACE)		0.97		0.9	77	70	TAL	- o.:	7		4 RT.	
	<u>, (a</u>	ALLIST	IC (AIR	085.1	, , , , , , , , , , , , , , , , , , , 	0.98	0	0.9	75		170					
4.0	FRIEL		100	1.50		-1	NOT	E: AE	BOVE	CORR.	NOT I	SED				
		1	A PARTY	AND REAL PROPERTY.	电影光线的 医多种	10 CT 10 CT	1.00								4800	
		1/8	2							BARDIE		1 2	2			
		1	715									1 2	. . -			
		OF EL	LUSTIG									1 2	2			
		0	\3		1							1 2	Δ.			
		0	ALLISTIO WING	Á	2							1 2	2			
		EN.	TO ME	À	V							1 2	pA			
	LIRFAC	EN.	TO ME	Á	2						R.	8	2 βΔ			FEET
	SURFAC	0	O WIND		¢						R.	GET	2			FEET
	SURFAC	EN.	O WIND		2 -						R.	8	gA			FEET
	SURFAC	EN.	O WIND		¢						R.	GET	A			FEET
	SURFAC	EN.	O WIND	FLIGHT	2						R.	GET	A A			FEET
	SURFAC	EN.	TO ME		4						R.	GET	A			
	SURFAC	EN.	O WIND	FLIGHT	v						R.	GET	A			FEET
	SURFAC	E	DIRECTION	FLIGHT	2						R.	GET	gA .			FEET
	SURFAC	E WIN	TANT DIRECTION	DACT.	•			B)			R.	GET	A			FEET
	SURFAC	E WIN	DIRECTION	DACT.	ED FOR	V DEFL		B)			R.	GET	A A			FEET

			TUDE	AIR:	R SPE		The state of the last of	RAIL A	F				
OMB-	TIME	100	GR'ND.	CAL.			SPEE	OR OR	HOR.	RAN	IONS F		CTION
	OF	OBS.	CBS.	IND.	AIR	GR'ND.	GR'NE	GLIDE	RANGE	J			
NO	REL.	, FT.	FT.			085.	M/	OBS.	*	100005352	SHORT		
1	7			7 HH.	ZHR	7148	AHM	FYMIN	F. No.	+1.	FJ.	11.	FT.
2	10:21	15860	15827	132	169.5.	165.8	140.8	+52.8	6158	122	246		408
3-					4.00	(48.0)		7	1000		2 10		400
4.			7 Y	1.00		W. 18.		10,000	1988	J	200	,,,,	
5				- De-					100	1776	8000	100	
6													
1000	100				•	J. CE	NTER	OF IMP	ACT		11 10		4.0
44				Ser.			MEAN	DEVIAT	ION.			100	
			T. Vin	TIME		8:4	6	10:55		CORRE	CTIONS	USED	en.
			E	A CONTRACTOR OF THE PROPERTY O	. 17	3.0		4.0		i in	RANG	77	EFL
VELO		BALLIS	TIC	0.40		27.1 24.4		22.6		•	, A.V.S		/EF E.
	H	DIFFER	ENTIAL	SRAM	SE .	- 3.0) [] •	-0.7	WI)	AD	- 0.6	C	.2 LT.
			LISTIC	CROS	3 S , 4	- 1,4	100	+1.0	DEN	SITY.	- 0.5		
DENSI		r-SURF) NEU∔STR	AGE C (SURI	FACE)		0.98	とこれ こくさん 著したべる	0.969			-		
Pare 9			C (AIR			0.96	CALL TO HOLD TO BE AND ADDRESS.	0.964	TO	TAL	- 1.1		.2 LT.
			-11					200	1456				
	81 F2"					P.	10						
			QNIM Y		0/		1000						
			2	(WILL !			15.					
100			- EN	87	1			110	i in	[-]		TAR	GET
50 you 4 24	7 7 -		BALLIST	3/	ı			400	!			, iiii i	J
100			BAI	1/8	52 1	4	445	4.2					
			}					1242	14 (45)			4	
	THE RESERVE OF THE PARTY OF THE	100											1.
				Committee of the Commit				CONTRACTOR OF THE PARTY OF THE	100				FEET
			Z	E .							warmen word	100	
		4	TION	. iGHT						562	1.31	阿尔西哥哥 斯	
			RECTION	FLIGHT									Z
			<u> </u>	151245500									NOIS
		4	DIRECTION	OF FLIGHT									PERSION
			DIRECTION	151245500									DISPERSION
			DIRECTION	151245500									DISPERSION IN

500

400

300

DEFLECTION IN FEET 200 100

RESULTS OF RANGE BOMBING NO. 34 AUG. 29, 1938 1000 LB. DEMOLITION BOMB M33 AIRPLANE B 18

SKY		ALTI	TUDE,	AIR:	R'SPE	b	GR'	40	CL)M	8		DEVIA	ED CN	DECEMBER OF THE PARTY.		
вома	TIME	AIR	GR'ND	CAL.	TR	UE	SPE	-	GUID	c 1.	HOR	D. P.	NGE	DEF	L.E.C	TION
NO	OF	-40 Asi	OBS	INO.	AIR	GR'ND.	GR)		GR'N	D	RANGE	OVER	SHORT	BIGI	17 1	EFT
	REL	FT	FT.		CBS.	M /up	10000-00	97.53	OFS FT/M		FT.	FT	FT	FT	6	FT:
7	11:20	5200	-	133	144.3				-34		3683	+	+			42
.2	11120	3200	3113	100	144.5	140.1	172		- 54		3000		+***	133	Ti.	
3	4.5			1.14					3.			173	100	1		90
4						10						1.545				
.5						100							8			214
6.					<u> </u>	L	<u> </u>			_1		1				2 B B A
	May 18				Mary .	CE	NTE	R	OF IN	IPA	CT	عتل	<u> </u>	<u> </u>		
<u> </u>							MEZ	IN	DEV	ATI	ON	1 37		ينيا	11	
		9		TIME		9:2	5	- 1	1:37			CORR	ECTIONS	.	3	* 4
	i i	SURFAC			1,000	8.0	TATOLOGICAL CO.		5.0	1	Mil	S IN	RANG	3E	· ĎΕ	FI
VELO		BALLIS	TIT ODE		47.5	3.5			0.2				4			
M.P.		OFFER	RENTIAL.			-2.5	j		1.8		W	יי סמו	- 0.	4	0):
	, (. BAL F SURF	LISTIC	CROS	8 5 °.	-0.3	1000		0.5	it is	DE	VEITY	— o.	3		
DENSI	TY \$5.		0.98 0.99 0.98	0	O	.974 .983		Ţ	OTAL,	- 0.	7	- 0)			
	To the Vi	1 1 1	C (AIR	1.15	i ii	0.50			.331	Ħ		1.**	100		TT	
		· ;					77		e e e		NOTE		CORR.		USE	D.,.
4/4				ONIM					1				to de			
											- 12 T	1-4		1:1		
			F						4		H.	1-4		+-1		() (S)
	1,4										[1	44	4.1	1		
			ВАІ	A								9			3.	Y L
		1	. 1	V								1.1				FEET
				100		40	821	•					4:11			
	i di sili		1	SURFACE 1H			88					TA	RGET			`` ≧
		4	H.	三一		74.7										, ig
				FLIGHT				7.7	7			1:1:		177		ER
	71 100	4	- A	SECURE SECURE	5	77 10		Ш			711	1-1-		-:		DISPERSION IN
	<u> </u>		MIND	P	1				4		* 1		77			. ^
·				DIRECTION			٠,,	*		4	10.11	4-4:	444	4-4		
			N. et .	. EC		1.12.2			1.1.		. L		4:4	4.	1	
7-1-V				E .		- Yit					. المالية					1.5
		ECENIO	15			100										
Tit.	4.4	LEGEND AGT		PACT		4						1 3 4				
		AUI	7.						77			77.50		150	, ,	
		into a second	10000	Der al seed	Course of the		4	4.00	W. Store Labor.	1			to be districted	4	House to	

O ACTUAL CENTER OF IMPACT

JULY	Y 6	. 1940		ESUL	AND ANY DESIGNATIONS	CATCHELL C	SERVICE CONTRACTOR		38 OK (48 YES)	The second second	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		LANE	B-18 A
200				LLINGS					ВОМВА	RDIER :	LT. M	. F. SUI	MMERF	LT
	SKY		LEAF	Anna Company of the Land Company	The state of the state of the state of	TOOMS					Charles and Colors		1100-A	THE RESERVE OF THE PARTY OF
1		TIME	ALT	TUDE	All	R SPE	E D		CLIMB OR			IONS	FROM	1000
BO	BMC	OF	AIR	GR'ND	CAL	TRU	JE .	SPEED	GLIDE	RANGE	RAN		DEFLE	
N	10.	REL.	OBS	OBS	IND	OBS	GR'ND	GR'ND	GR'ND		OVER	SHORT	RIGHT	LEFT
			FT.	FT.	M/HR	M/HR	MHR	MHR	FT/MIN	FT.	FT.	FT.	FT.	FT.
	1	10:05	1046	10396	140	165.0	166.4	160.0	-130.6	5731	6		4,4(-18)	. 48
	2	10:15	1044	10397	143	168.5	165.5	159.1	+ 3.7	5809	144	All the	48	10000
-	3			5.50		200	7.0							
	4		Thought.		-77							3 - T.A.	1000	54.33
	5 6						5 75-1(4.3% 5 (4.3%)			1000		10 (2 d g		
	0		1 (8)	1		1	CE	UTER .	OF IMP	PACT	75		0.0	
*	100	2 8	in an						90018/AST 1969	Account to	6	A CONTRACTOR OF STREET	Section 18	8
-	7.2%			-					DEVIATI	,				
	Sec.			2-20 MHz	1110	<u> </u>		-	.0.5.	R.O.	-	MERA		
				L	SURF	005			8:00	10:3	description exercises	0:23	13/55/5	4.
		h. ik.	V	IND	The second second second	LTITUO	F	CONTRACTOR STATE	4.0 7.3	5,0 13:9	the same of the sa	5.0		
				CITY	-	ISTIC R	NAME AND ADDRESS OF TAXABLE PARTY.	make set about	-		Colorado Mario de	7.8		
				P.H.	BALL	ISTIC C	ROSS V	mid -	8.0		Constituted Sections	0.1	17.4	
	A PARTY.	en de la companya de La companya de la co		33715	AT S	URFAC	ε		0.989			0.968		100
1		1.6	DE	SITY		ISTIC			1.000	19.00		0.986		A Sign
L.		7.5			BALL	ISTIC (AIR OF	(S.)	1.004			Contraction of		
12.					10.16		1.2			1212	145			
				West St		1-531			15 (5)	Property of			(Cotto)	1.5
1			1		drift.					ludio.			2	
			Γ		- 5	n.				11217	PERMIT			15.75
	43				Z.S		C. 64		17.00	1.12	le des	7.91		
Tirt		15	100		9//	1			17 (77)	To die			67, 17,	1 334
4		1457		1		15.16	137.7	 	17.18-7	0011	14 T			i ii
			to the the	00//-		1.0		Hornin	Harri	1000	11 11 17	hiire		2
عظة			1 5		4:						9	-TAR	GET	**************************************
SU	RFA	CE WIN	ID /			1-45				4-24-2	10.74		i a ciris	Sic
						100		1	1.46		107.0	100	di dira	Œ
		× 14/				1234		1 41	L.M.	1,52			Tide.	DISPERSION
	.0	//	70 5	2				1 (11.1)		14 55				ਿਨ
1	1		177		81/19	100	15 (A)		100	910	1.47	-11:1	444	PAL
1	1		00.0	18,445			Par.	15/12						
-		, i	15.64	Sept.					7133		1 X 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Jun.		4 51 19
	GE	100000000					-		total			1012		grafic it.
. 0	AC	TUAL	IMPA	515			Contract of	100.1	4 (4)	parts of				

DEFLECTION IN FEET

RESULTS OF RANGE BOMBING NO. 68 JULY 10, 1940 HOO LB DEMOLITION BOMB M33 AIRPLANE B-17 B

SKY	.: NO		UDS TUDE	Contract Contract			And in case of the last of the	CLIMB		Market State Company of the	BARRIO DE LA COMPANIO		
	TIME		1	d : Alf		A CALL OF BUILDING	SPEED			1018 10 10 10	TIONS		
ОМВ	OF	AIR	GR'ND		TRU	JE		GLIDE	September 1	RAN		DEFLE	100000000000000000000000000000000000000
NO.	REL.	OBS	OBS	IND	0.85		0.85	GR'ND OBS.	100	OVER	SHORT	RIGHT	LEFT
		FT.	FT.	M/HR	M/HR	M/HR	MHR	F //MIN	FT	FI.	FT.	FT.	FT:
i .	10:09	10540	10500	143	168.8	172.1	159.1	+117.4	5826		324	900	51
2	10:19	10560	10598	143	169.1	168.2	155.5	+366.5	5686	36	34.6	Angel:	225
3	Section 40		21344		9.077		100				eder Yes	2,476	
5			-	Alder C			7		7.				
6		2 2 2 2 2							100		10000	or per in	er ill der
	44		for a second			CFI	VTER (OF IMP	ACT		144		138
9.45	1872 X	1, 1					State State	DEVIATI	and Constitution		8.0		7
-													
N. I. Y.	in the state of		71	ME		17 18 18		0.5.	R.O.		MERA	303 (41-)	
		1.5		SURF	ACE		-+	9:45			5.0	1000	
			IND	Section of the second	LTITUO	ε					4.3		
			CITY:	BALL	STIC R	ANGE V	/IND	ethan frigh	1	-	11.2		
Ġ.				BALL	STIC C	ROSS W	MND				8.6		
					URFAC		THE REST PROPERTY.	0.966			0.997		
	* *(4)	DEN	SITY		ISTIC		-	0.985			1.005	1 14 14	
and the second				BALL	STIC (AIR OF	S.11	1.000			1 14 171		1
					1, 1, 2,		NO	TEL CA	MERA	0850	JRA W	INDS	E
			124116		4	20,000				1000	Charles of		H
			120192	N.	27 July 1	9		1		1.645.	l'ille:		2
	2			1							TAR	FT	
	P.			71			Section.				terini.		NO NO
	\^_	ie H	157								(-1:	Silv :	DISPERSION
	(2)	1712			7,3			13.75	Office:	and the		14.7	125 O.
	1	, le	/			ocalda.	100		77.12		(VE)		018
7767		119	4	A STATE OF THE ACT	10 17 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				Control of	451		Six Lin	
2011年5 第21年5		10	P+				1. 4.	C.I.	The FEW	in in	1	1-4	Pate
127		A	×				*	O			1		1.4.7
4.1.	139	z	· 30 .		MLp (L. 4. 5		2.5		1.			
	7	O		16 7		STATE		12. Asia	1 000		1034	100	1323
1117	(S)	DIREC	1818	0			173					1 on	
3	1	DIR		1			1.00				世界是	Policies and the second	13.73
EGE	VD.	and the					2001/20	147			i jer	1207	31,150
	TUAL	IMPAC	TC			1	1 1 2 1	133		100	te him	1	
			R OF	MPACT					17.27		1.00		
7,70	OML	ULIVI C	i or	CHARL				191.1		9	l Xaric		dent.
111		A LONG	4-64-5	191 1500	LT STORY	Ministry	00	1	DEFL	EG (10)		EET IC	1000

OCT. 22, 1940 1100 LB DEMOLITION BOMB M33 AIRPLANE B-178

BOMB OR OR OR OR OR OR OR O		TIME	ALT	TTUDE	IA:	R SPE	ED	GR'N	0 0	LIMB	32.00	DE	/IA	TIONS	FRO	OM 7	TAR	GET
NO REL OBS OBS IND OBS OBS IND OBS	OMB	www.n.i.ii	AIR	GR'ND	CAL.			SPEE	D	OR	HOR.	R	AN	GE	DE	FLE	GTI	ON
FT: FT. M/HR M/HR M/HR FVMN FT. FT. FT. FT. FT. FT. FT. FT. I ET. I 2.37 25430 25463 145 216.8 220.6 187.3 + 28.1 10509 372 528 258 22.47 25410 25442 145 216.7 223.7 192.4 - 6.2 10311 327 258 3 2.56 25410 2547 14.9 222.8 230.1 197.1 + 25.9 11464 858 678 4 3:07 25422 25553 149 223.1 218.5 196.7 -229.6 11153 231 44.4 5 6 6 78 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	NO.		OB	OBS	IND	AIR	GR'ND	GR'N	D G	R'ND	RANGE	100	-		0.770			P PAGE
1 2.37 25430 25463 145 216.8 220.6 187.3 + 28.1 10506 3.72 528 2 2:47 25410 25442 145 216.7 223.7 192.4 - 6.2 10311 327 258 3 2:56 25410 25447 149 222.8 250.1 197.1 + 25.9 11464 858 678 4 3:07 25422 25553 149 223.1 218.5 196.7 - 229.6 11153 231 444 5 6		NEL.	FT.	FT.	M/HR	M/HR	M/HR	MAH	F	VMIN	ET.	F		30.00	100	0.00	1000	
2 2.47 25410 25442 145 215.7 223.7 192.4 - 6.2 10311 327 258 3 2.55 25410 25477 14.9 222.8 230.1 197.1 + 25.9 11464 858 678 4 3.07 25420 25553 14.9 223.1 218.5 196.7 -229.6 11153 251 44.4 5	1	2:37	2543	0 25463				Control of the last		200 200 200		-	-		H			
3 2.56 254IC 25477 149 222.8 230.1 197.1 + 25.9 11464 858 678 4 3.07 2542C 25553 149 223.1 218.5 196.7 - 229.6 11153 231 444 5 6	2											Ť		327		37.5		
4 3.07 25420 25553 149 223.1 218.5 196.7 229.6 11153 231 4444 5	3	Control of the Contro	A STATE OF THE STA	The second secon								8	58	ake (See	-	78	11.1	
CENTER OF IMPACT 284 138	the same of the same of	3:07	2542	0 25553	149	223.1	218.5	196	7 -	229.6	11153	2:	31				4	44
CENTER OF IMPACT 284 138			7	1	-		, 24								5,61 5,41	14		
R.O.S. R.O.S. CAMERA	ь	1 2 2	L	<u></u>	<u> </u>	100	051		Ť			6.44		100		11		
TIME 1:59 3:09 3:07 WIND VELOCITY AT ALTITUDE 40.1 38.8 37.6 BALLISTIC RANGE WIND -26 3 -21.4 BALLISTIC COSS WIND 14 8 14.6 AT SURFACE 1.057 1.059 1.045 BALLISTIC (SURFACE 1.031 1.032 1.027) BALLISTIC (AIR OBS.) 1.007	X 1,240.	100				1 1 No	WWW.MINTER	Section 1	1800				(5.0)			7	;	38
SURFACE 8.0 6.0 7.0 WIND VELOCITY AT ALTITUDE 40.1 33.8 37.6 BALLISTIC RANGE WIND -26 3 -21.4 BALLISTIC CROSS WIND 14 8 14.6 DENSITY BALLISTIC (SURFACE 1.031 1.032 1.027 BALLISTIC (AIR OBS.) 1.007 BALLISTIC (AIR OBS.) 1.007 TARGET NO.008 TARGET NO.008 TARGET NO.008 TARGET NO.008 SURFACE 1.059 1.045 BALLISTIC (AIR OBS.) 1.007							. Ale N	EAN	DE	VIATI	ON	190	33	2		4 (380	15
WIND VELOCITY AT ALTITUDE 40.1 38.8 37.6 BALLISTIC RANGE WIND -26.3 -21.4 BALLISTIC CROSS WIND 14.8 14.6 AT SUFFACE 1.057 1.059 1.045 BALLISTIC (SURFACE 1.031 1.032 1.027 BALLISTIC (AIR OBS.) 1.007 BALLISTIC (AIR OBS.) 1.007 THE SURFACE 1.031 1.032 1.027 BALLISTIC (AIR OBS.) 1.007									_	-	R.O.	s.	CA	MERA				
VELOCITY AT ALTITUDE 40.1 38.8 37.6	1317	451911.4	1000	Т		19K40		4	1000000	With the State of	ATTICIONADO DE LA COMPANSIONA DEL COMPANSIONA DE LA COMPANSIONA DE	0	100				1 - 1/N	1000
VELOCITY BALLISTIC RANGE WIND -26 3 -214 BALLISTIC CROSS WIND 14 8 14.6 AT SURFACE 1.057 1.059 1.045 BALLISTIC (SURFACE 1.031 1.032 1.027) BALLISTIC (AIR OBS.) 1.007 BALLISTIC (AIR OBS.) 1.007					Annual Control of the	A SAN DESIGNATION OF THE SAN DESIGNATION OF T	-		_									
BALLISTIC CROSS WIND AT SURFACE 1.057 1.059 1.045 BALLISTIC (SURFACE) BALLISTIC (AIR OBS.) 1.007 BALLISTIC (A		ALC: Y	VEL	OCITY	-		-	-	70.1		Contract of the Contract of th	delibera la	Victoria I				3	1.71
AT SURFACE 1.057 1.059 1.045 BALLISTIC (SURFACE 1.031 1.032 1.027 BALLISTIC (AIR OBS.) 1.007					-	-	-			Control (CA)	Contract Contract			Control Property		1		
DENSITY BALLISTIC (SURFACE 1.031 1.032 1.027 BALLISTIC (AIR OBS.) 1.007 STARGET NOTE: The surface of the sur		t bran			AT S	URFAC	E		1.0		All the second second	59					1 2 2 4 2 4 5 5	
TARGET ON WEEK.			DE	VSITY	BALL	ISTIC (SURFA	CE	-		-		-					
TARGET OF TARGET					BALLI	STIC (4	VIR OB	s.)	1.0	007								
TARGET OF FEET					1,121	Mago		157		di.		15						
DOPERSION IN FEET			A	<u>, Maril</u>	10.49	6-11.						Hall:						
OUNC CTION OF FURTHER WAS A STREET.	1100			de la	ince his	•		2 k		7 P 17	gajila	Sing.		Pri l		20		
DOMECTION OF FLET	1. 6				1											T.Y		
DESCO IN FEET		6			4	1	10											
DESCO IN FEET		6	S					N. S						File				
TARGET ON IN FEET	Hel			/	3500							4.1	75					
EGENO IN FEET		11.1		A . James	M. Tarit				7	1,					17,			
ECENO IN PERSON IN PERSON	of the	34.	4 3	X H	- 1	124		- 0		100	6.1					\$2.15 5.55		
EGENO 2			X			23.) €		第二日	1							14.5		
EGEND 2 TARGET NO. STARGET NO.		100	4	(3	4.4		1974				· · · · ·	1711		11.00	Mil		7.1	E
EGEND 2 TARGET NO		1	-4.2	18				14.								-44	+(400
EGENO 2		/					a di N						90				7444 7444	0.000
EGENO 2	/	人性的	1 0	1/2		12/2				10	25	TA		N. B. S	Siif			NO
EGENO 2	1				1		17.17	A. K.							Sil.			181
ACTUAL IMPACTS	EGEN	0			1		100				31.5						1:17	PE
TO SECURE A SECURIOR ASSOCIATION AND A SECURIOR ASSOCIATION ASSOCIATION AND A SECURIOR ASSOCIATION ASS		The second second	MADA	1.		3477	111	7.7	1	. 6	, wind							SIC

800

4.	171.00 S	ALTI	TUDE	ΔΙ	R SPE	ED	GR'NI	CLIMB	A. DA	Control of the Contro	Charles and the Contract of th	-1100 FROM 7	The same of the sa
ВОМВ	TIME	AIR	GR'ND				SPEE	CONTRACTOR OF THE PARTY OF THE PARTY.			and the same		
NO.	OF	OBS	OBS	IND	AIR		GP'NF	GR'ND		RAN		DEFLE	
	REL.	Add to an		Part Tree	085.	OBS.	OBS	OBS.		OVER	SHORT	RIGHT	LEFT
	7.7.	FT.	FT.	M/HR				FT/MIN	AND THE PROPERTY OF THE PARTY O	FT.	FT.	FT:	FT.
2		-	25768			The second second second second		- 27.5	Name and Address of the Owner, when the Owner, which				807
3	Control of the Contro		25773 25672					+486.2				10.33	33
4		The second second	The second second	And the Control of th	214.5	225.8	1771	+ 31.3 - 3346	0173	180	0.51	390	2.7
5		44.9	11000			220.0		3346	9173		651	204	
6	TWEET,				27.1	100			1				
				7 (174) 37 (174)		CEN	ITER.	OF IME	ACT				62
77.5	Control of the second					M		DEVIATI	Aliconia della	3	25	2.	73
								2.0.5.	R.O.		MERA		
		Series.	· 11	ME			_	2:50	4:0		1:00	:	
				SURF			CONTROL BOOK	3.0	11.0		2.0		
	781	VELO	ND CITY	-	LTITUD	Contract of the last			59.7	_	9.0	Contract Con	i vi
		M.			STIC RA		Name of Street,	-32			5.3	100	1.14
			4	50 50 000 000 000	STIC CF	-	ND -	. 24	.0	2	0.1		2.1
1 + P P - 1 / 1		DEN	SITY		URFACI		CE)	1.010			1.013	1	S-110 /
					STIC (A			1.014		+	1.015	1	
		n Arm			44.1		* 177			G 21	307-27		
							rir Frit			1.1.1.1			
	73.23	A	15-15-5					100 25 12	10,14 m 2 m 10,18 m 2 m			Carrain Carrain	10100
OP.		17		1	7 1 3 1								
K				4				21136		2		3	
7	(t)	icH1			1 3 7		1,15	104		17.47			
	1/2	9.7	_/							CI.	TARGE		
	130	· v.						104-11					
17.51		1 6		- Oltal D	To the same			ralis.	Wirth				5
		SI	REACE	WIND				Hillin		id.	4 100		1
			2			3 30	4707	Sape.					1
11.24	1		0	44.50		14.0	21 67	111111	510.11	7.17			
	/	NO.	Ex	171			75 75	.alian					ő
		5	7		, i ; ; ; ; ; ;	Tital		200 per 3			4		DISPERSION
6		DIREC		/								16 11	i de
CCN				-	100						136.7	THE STATE	
GENI	*							Tikul:				90	
ACT		MPACT										40 11	
ACTL	JAL C	ENTER	QF I	MPACT		41			igiji I			111	
7 1 2 1 2 2 2 2					THE PERSON NAMED IN COLUMN 2 IS NOT THE OWNER.	ACRES AND ADMINISTRATION OF THE PARTY OF	A STATE OF THE PARTY OF THE PAR		THE RESERVE AND PARTY AND PARTY AND PARTY.	THE RESERVE AND ADDRESS OF THE PARTY OF THE	Access to the second of	the state of the same of the same	A STATE OF THE PARTY OF THE PAR

NOV. 20, 1940

			LOUDS TUDE	Control of the Control	R SPE	CONTRACTOR OF STREET		CLIMB		Section Section 1	TIONS		
вомв	TIME	AIR	GR'ND	CAL	TR		SPEED	GLIDE	HOR.	RAI	VGE	DEFLE	GTION
NO.	OF REL.	OBS	OBS	IND	AIR OBS.	GR'ND OBS.	GR'ND	GR'ND	RANGE	OVER	SHORT		-
	net.	FT.	FT.	M/HR		M/HR	OBS.	FT/MIN	FT.	FT.	FT.	FT.	FT.
1	10:15	25430	25526		The same of the sa		THE RESERVE AND ADDRESS.	-100.7	the state of the s	72			612
2	10:28	23250	23496	149	215.9	219.5	170.6	- 34.9	9173	540	06 - 32	*	21
. 3		100	1-12-12		ļ						12.5	30.37	1000
5											Section 1	200 T 100 T	0.7
6				-							-		an expect
- 43- 57	14.00					CEI	ITER :	OF IMP	PACT	306	11.25		317
	454 J.,			e de la companya de l		1,	EAN I	DEVIATI	ON	2	34	25	96
							R	.0.5.	R.O.	S. GA	MERA	1000	
			TI	ME				36	10:45	-	:28	1 P 1	
		wi	ND	SURF	***			2.0	13.0		6.0		(W
* * * * * * * * * * * * * * * * * * * *		VELO	CITY		LTITUD STIC R	the second second		9.3 -36	80.0	-	0.6 3.2	1.00	1.6
		. M:	Р.Н.	-	STIC C			+44			9.5		
					URFAC	-		1.054	1.0		1.043		
		DEN	SITY		ISTIC			1.031	1.0	28	1.026		
11 - 1	e let s			BALLI	STIC (AIR OB	5.11	1.017				<u> </u>	
												0	
		- A	77										14 (17)
		aller Total			r							<u> </u>	
341	IC WIND	ieH:		A	la de la		14.4		C.1				
10	~			Z			1		O				<u> </u>
	W/A.		/	5 7 77		6,12 p 1		14					
1		5	<i></i>	2 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1 (1		1			4.74		1000	Charles Inc.	
		X	SURFAC	E WIN	ID >			3, 13					- 5
			WINO AT					(Cont.)	1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 - 1 -	1.1.1.	Marie .		3
i mili	-/	N O	A	di:	27.2	•		-1				19.13	<u>z</u>
	<u> </u>	- -		X.			433 133	1.5° E.Y			TAF	GET I	
6		DIREC			7				110				DISPERSION
			1,12							A A A		76.74.73	- a.
EGEN	U.	73.4		COURSE OF	160		ALC: YOU		45 8 5 1 1 7 1 1	\$369 PM	STATE OF THE PARTY.	93.6	C)

600

400

200

Appendix C

Individual Standard Elements and Ballistic Coefficients from Reduction of Field Data

Appendix C

				Appendi					
		Y	ប	Х	T	λ	c_{X}	c_{T}	c_{λ}
Program Group Serial	Date of Release Run No.	Standard Altitude	Standard True Air Speed	Standard Range	Standard Time of Flight	Standard Trail			
Number	nar w.	ft.	mi./hr.	ft.	sec.	ft.			
KS-126-	-2 6/6/382	10000	160	5735	25.41	228	4.69	3.55	3.97
	1 6/14/38-1	10000	160	5 7 55 5704 5699	25.49 25.12 25.10	22 7 191 191	5.63 3.69 3.55	3.13 9.70	4.13 5.00
	6 6/30/38-1 2	10000	160	5669 5762	25.51 25.29	317 173	2.93	10.20 3.05 4.75	4.95 2.99
	8 8/19/38-3	15000	160	6854 7004	31.68 31.33	580 348	2.46	2.48 3.60	5.41 2.47
	10 5]		7033 7019	31.53 31.33	366 3337	5.88 5.27	2.86 3.60	4.13 3.97 4.31
	11 8/22/38-2 12 8/23/38-2 13 8/29/38-1	5000 15000	160 160	4184 6884	18.04 32.06	48 639	-6.23 2.74	1.94 1.84	4.46 2.21
	13 8/29/38-1 14 5/24/39-1	5000 2000	160 160	4055 2616	17.91	148	3.34 82.41	2.85	3.15
	14 5/24/39-1 15 2 16 3			2606 2616	11.25 11.20	33 13	9.79 98.90	2.97 5.44	5.29 13.64
	17 4 18 5			2628 2611	11.23 11.23	8 26	-12.49 16.49	3.46 3.40	22.28 6.89
	1 7/6/401 2	10000	160	5661 5744	24.99	204	2.81 5.00	33.87	4.67
†	4 7/10/40-1 3 2 8 10/22/40-1	10000	160	5722 5664	25.25 25.17	203 243	4.17 2.87	5.63 7.48	4.70 3.93
	8 10/22/40-1	25000	200	11240	41.10	816	5.01	3 . 74	4.27
	6 3			10835 11584.1	41.32 41.12	1285	2.15	3.25 3.68	2.60

Not included in group mean for the reason given on page 8 of text.

Appendix C (Cont'd)

		Y	Ū	Х	T	λ	CX	$c_{\mathtt{T}}$	CX
Program Group Serial Number	Date of Release Run No.	Standard Altitude ft.	Standard True Air Speed mi./hr.	Standard Range ft.	Standard Time of Flight sec.	Standard Trail ft.			
KS-1265 11 12	10/22/40-4 11/4/401 2	25000 25000	200 200	11366 11412 11089	41.35 39.76 WE 40.24	764 572 716	8.25 10.79 3.38	3.18 211977 8.30	4.57 6.37 4.97
9 10 13 14	3 4 11/20/40-1 2	25000	200	11283 10650 10846 11209	41.05 40.50	1194 670	5.81 1.69 2.19 4.57	3.87 6.17	2.84 5.28

Appendix D

Mean Standard Elements of Altitude Groups and Relations Between the Ballistic Coefficients and the Altitude of Release Appendix D
Table 1
Range

						Kange					
	Y	U	V	N	P	Χ	$^{\mathrm{r}}\mathrm{_{X}}$	CX	$^{\mathtt{r}}c_{\mathtt{X}}$	$^{\mathtt{C}_{\mathbf{X}_{\mathbf{y}}}}$	X-X _f
		Standard True Air Speed	Calibrated Indicated Air Speed Corre- sponding to Standard True Air Speed	of	of	Mean Standard Range	Probable Error of Mean Standard Range	Coefficient Correspond-	Ballistic	Coefficient from C:Y Relation	Mean Standard Range Minus Range Corre- sponding to C _X
	ft.	mi./hr.	mi./hr.			ft.	ft.				ft.
ر د	35000									3.23	
اد	30000									3.31	
	25000	200	134.8	9	1.16	11103	60.0	3.49	0.472	3.41	11
	20000									3.55	:
1	15000	160	126.3	5	0.00	6959	25.1	3.81	0.476	3.79	- 4
	10000	160	136.6	10	1.72	5712	8.1	. 3.85	0.225	4.27	-14
	5000	160	147.9	2	0.26	4120	43.6	15.04	35.06	5.98	28
	2000	160	155.0	5	0.86	2616	5 2.5 0	57.80	75.46	28.88	2 .

(000 -

Appendix D
Table 2
Time of Flight

77		1 - 17	T - 57		<u>llme or</u>	_Flight				
Y	U	'	N	P	Time of	Γ	$C_{\mathtt{T}}$	$r_{C_{\underline{T}}}$	C _{Ty}	T-T _f
Standard	Standard True Air	Calibrated Indicated				Probable	Ballistic Coefficient		Value of	
ALULUAGO	Speed	Air Speed		Groups	Time of	' Mean	Correspond-	Ballistic	Ballistic Coefficient	
	1.	Corre-	'	. ,	Flight	Standard Time of		Coefficient Correspond-	from C:Y	Flight Minus
	1	to	1	·	1	Flight	Time of	ing to Mean		Time of
	1	Standard True Air	'	'	1	1	Flight	Standard Time of	1	Flight Corre-
	1	Speed	. '		1	1	1	Flight	1	${f sponding} \ {f to} \ {f C_T}$
. !	1	1	' '	1	1	1	1	1	1	Ty
ft.	mi./hr.	mi./hr,	<u> </u>	<u> </u>	sec.	sec.				sec.
35000	1	1.		1	1	. !			4.84	
30000	1	1		'	1			1	4.81	
25000	200	134.8	7	1.16	40.80	0.137	4.66	0.520	4.78	0.03
20000		+ - !	1		1				4.74	ĺ
15000	160	126.3	5	0.00	31.59	0.092	2.69	0.237	4.69	0.43
10000	160	136.6	9	1.72	25.26	0.041	5.46	0.698	4.60	-0.06
5000	160	147.9	2	0.26	17.97	0.043	2.31	0.295	4.40	0.16
2000	160	155.0	4	0.86	11.23	0.006	3.64	0.293	4.06	0.01

Appendix D Table 3 Trail

		···		, 		· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·			
Y	Ū	v	N	P	λ	$\mathbf{r}_{\lambda^{'}_{i}}$	C _{Àt}	r _{C λ}	c y	λ-λ . F
Standard Altitude		Calibrated Indicated Air Speed Corre- sponding to Standard True Air Speed		of	Standard	Probable Error of Mean Standard Trail	Ballistic Coefficient Correspond- ing to Mean Standard Trail	Probable Error of Ballis tic Coefficient Correspond- ing to Mean Standard Trail	Value of Ballistic Coefficient from C:Y Relation	Mean Standard Trail Minus Trail Corre- sponding to C
ft.	mi./hr.	mi./hr.			ft.	ft.				ft.
35000				,					3.90	
30000					-			`.	3.95	
25000	200	134.8	7	1.16	860	69.3	4.04	0.361	4.01	-6
20000									4.09	
15000	160	126.3	5	0.00	453	43.6	3.20	0.315	4.22	110
10000	160	136.6	9	1.72	220	9.6	4.34	0.190	4.46	6
5000	160	147.9	2	0.26	98	33.5	4.73	1.629	5.12	8
2000	160	155.0	4	0.86	20	3.9	8.80	1.72	7.25	-4 -

